14 FUTURE DIRECTIONS FOR THE MBSS

The success of the 1995-1997 MBSS has encouraged DNR to continue its stream monitoring. DNR has begun planning for a second round of the Survey by developing a new set of management questions that reflect what has been learned in the first round of the Survey, as well as the evolution of management and policy concerns since 1995. To this end, the Monitoring and Non-Tidal Assessment Division has solicited comments from all parts of DNR on a draft set of management questions and will use these responses to help determine whether design changes or method refinements are warranted.

Most of the original 64 MBSS questions that have not yet been answered dealt with identifying potential stressors using data not collected as part of the Survey. Much of this information can be gathered from other sources and linked to MBSS sites so that statewide estimates can be made of stressor extent (e.g., number of stream miles with point sources of contamination, amounts of pesticides applied by geographic area, or pattern of landscape patches in upstream catchments). A few of the original management questions are impossible to answer with current data; some others are of only minor interest.

New management concerns likely to be incorporated into the next round of MBSS monitoring fall into the following categories:

- Comparing among sample rounds for detection of trends
- Extending into smaller and larger streams, while delineating more stream types
- Characterizing and assessing at finer geographic scales
- Better characterizing existing and new stressors
- Refining existing indicators and developing new ones
- Improving identification of rare species and other biodiversity components.

14.1 TRENDS DETECTION

As mentioned earlier, one of the main reasons for implementing the 1995-1997 MBSS was to create a baseline for comparison with future monitoring results. Therefore, it is critical that the second round of MBSS sampling is designed to take full advantage of this baseline. One of the most promising approaches is to include a subset of fixed sites (i.e., sites sampled during the 1995-1997 MBSS) among a larger set of random sites that can still provide areawide estimates. This type of design is generally referred to as partial replacement.

An important factor in evaluating potential trends is natural interannual variability. Some investigators have reported dramatic changes in stream biota with unusual precipitation events, although this is not always the case. Using the 1995-1997 results from basins sampled in two years and from repeat visits to selected sites, we have an preliminary assessment of the magnitude of this variability. This information will be used to determine how the power to detect trends will vary with the frequency of and density of samples.

Trends in natural resource condition are most useful if they can be related to associated trends in specific stressors or human influences in general. In future years, the MBSS team will be linking changes in land use obtained from remote sensing data (MSS or AVHRR imagery) to stream monitoring results. Other potential sources of stressor trends will also be investigated, and the second round of the Survey will be designed to continue tracking changes in acid impacts related to implementation of controls under the 1990 Amendments of the Clean Air Act.

14.2 ENHANCED SAMPLE FRAME FOR ALL STREAMS

Even though the 1995-1997 MBSS sample frame was restricted to first- through third-order streams as described on 1:250,000-scale maps, many more small streams were assessed than in any other study of this magnitude. Partly because of this historical neglect of small streams and their susceptibility to degradation, it is important that the Survey monitor additional smaller streams. This can be accomplished by basing the second round of the Survey on a sample frame of streams as described on 1:100,000-scale maps.

At the same time, the Survey would be further enhanced by adding 4th-order and larger streams to include all streams above tidal waters. To this end, the MBSS team has conducted methods comparisons in larger streams that can be implemented in the second round of the Survey. The MBSS team is also considering expanding the Survey to include tidal creeks. A pilot study has already been conducted by DNR (Hall et al.1999a) in order to assess the feasibility of assessing the biological condition of tidal

streams in Maryland. A conversion model for sampling results using different protocols will be needed if integrated areawide estimates are to be calculated.

A third enhancement of the sample design for the second round of the Survey would involve designating additional strata for assessing distinct stream types, such as coldwater streams (<22 degrees C). Several researchers have noted that high-quality coldwater streams have fewer species and taxonomic groups than high-quality warmwater streams (Lyons et al. 1996). While such streams are naturally dominated by salmonids and cottids, environmental degradation often causes an increase in species richness (as a result of the invasion of more tolerant eurythermal and warmwater species), the opposite of what occurs in warmwater assemblages. The second round of the Survey should consider designating coldwater streams (and perhaps blackwater or other unusual stream types) for separate sampling or indicator development.

14.3 FINER GEOGRAPHIC SCALES

The needs to detect trends and to assess more stream types will be critical factors in the design of the second round of the Survey. In addition, natural resource managers and policymakers at DNR and elsewhere have an increasing need for assessment results at geographic scales finer than statewide and basinwide. Specifically, the Integrated Natural Resource Assessment and Unified Watershed Assessment are using 8-digit Maryland watersheds (138 in the state) for targeting, while specific protection and restoration projects may require using 12-digit watersheds (1166 in Maryland) or other methods to define the specific boundaries of the stream problem. This poses a difficult challenge because increasing sample density at finer scales substantially increases sampling effort. Therefore, DNR will be evaluating the new management questions to determine the best balance of fine-scale assessment, statewide coverage, and frequency of reporting (including the need to support 305b reporting to EPA).

Power analysis on the 1995-1997 MBSS results will be used to inform this design. One option under consideration is to decrease sample density for statewide estimates on an annual or other frequent basis, while supplementing this effort with more intense sampling in selected basins (and small watersheds) on a rotating basis over several years. The MBSS team is also considering using a simple random design (i.e., eliminating stratification by stream order) that would simplify calculating estimates and reporting results. It would also have the effect of increasing the proportion of sample sites on small streams (because streams would be sampled in proportion to their abundance).

14.4 BETTER STRESSOR CHARACTERIZATION

In addition to seeking finer resolution on the geographic boundaries of stream problems, natural resource managers are always searching for more information on potential stressors. The 1995-1997 MBSS made a conscious effort to balance the desire to collect as much stressor information as possible at each stream site with constraints on sampling time and analytical costs. Lessons from the first round of the Survey have identified ways of streamlining some data collection as well as candidates for additional stressor data collection. As initially conceived, substantial stressor identification will continue to be done using remote sensing and other data sets that can be linked to MBSS sample sites.

While the water chemistry parameters related to acidification have done a good job of elucidating this problem, collecting only nitrate-nitrogen has limited the utility of assessments of nutrient problems. The addition of phosphorus and other nitrogen compounds is being considered for the second round of the Survey. Adding analyses for fish tissue contaminants or pharmaceuticals (from animal feedlot discharges) is more problematic and costly. Dissolved oxygen will continue to be measured and ways to better assess results in light of diurnal and seasonal fluctuations are being considered. Perhaps most importantly, it has become apparent that continuous recordings of summer temperatures are important for identifying coldwater streams specifically and watershed disturbance in general. The MBSS team deployed temperature loggers in 5 of the 7 basins sampled in 1997 and plans to deploy temperature loggers at all future MBSS sites.

The quality of physical habitat in streams has long been recognized as an essential factor in the health of aquatic ecosystems. The 1995-1997 MBSS collected a large suite of qualitative and quantitative physical habitat parameters. It is important that effective measures of habitat quantity be built into the analyses of MBSS results. For the second round of the Survey, the MBSS team will consider consolidating some measures, but also adding parameters to better address (1) sedimentation effects, (2) differences between channelized and natural streams (i.e., levels of sinuosity, flow, large woody debris, and rootwads), (3) extent of artificially constrained floodplains, and (4) extent of migratory fish blockages.

The status of riparian vegetation also plays a critical role in maintaining stream integrity. In addition to the parameters collected in the 1995-1997 MBSS, the second round of the Survey may include tracking the loss of mature riparian vegetation (that provides greater stream and watershed benefits). Equally important is validating the utility of remote sensing information on riparian buffers with more accurate visual records. In particular, the Survey can provide one of the most effective means of understanding the extent and effect of piped discharges that bypass riparian vegetation.

It is also important to recognize that the biological indicators used in the Survey will continue to identify stream problems where the causes are not immediately apparent from associated stressor data. Finding new ways to identify causes of degradation (or of focusing additional monitoring that may) has implications for regulation of streams under the Clean Water Act (specifically, adding such sites to state 303d lists and ultimately preparing TMDLs for affected streams).

14.5 REFINED AND NEW INDICATORS

The use of rigorous, reference-based indicators has been a powerful means of assessing the condition of Maryland's streams and identifying likely causes of degradation. As described above, new ways of collecting or analyzing stressor information can lead to effective new indicators of human influence. One specific example is development of an indicator of impervious surface that can be derived from remote sensing land cover data. For the second round of the Survey, the MBSS team is considering developing the NDVI as an indicator for landscape stress. The MBSS team is also considering developing a combined ecological stress index (e.g., combining water chemistry, physical habitat, and landuse).

Although the fish IBI, benthic IBI, and physical habitat index have been validated and proven useful for assessing the results of the 1995-1997 MBSS, it is possible that these indicators could be improved with the identification of additional reference sites. The MBSS team is considering two efforts: (1) comparing MBSS reference sites with independently selected sites based on best professional judgement and (2) delineating the extent of current reference areas, possibly identifying better reference conditions near current sites.

The difference in results sometimes obtained between the fish IBI and benthic IBI emphasize the importance of assessing biological integrity with more than one organism group (as recommended by EPA 1990). Given that the fish IBI cannot be applied to streams draining watersheds smaller than 300 ha, and that more streams of this size will be included in the new 1:100,000-scale sample frame, a new biological indicator may be warranted. Currently the best candidate appears to be streamside salamanders, which can be quite abundance and diverse, especially in the western part of the state. The MBSS team is also considering combining the various biological indicators into a composite biological integrity index (e.g., the mean of the fish IBI, benthic IBI, and salamander IBI).

14.6 IMPROVED CHARACTERIZATION OF BIODIVERSITY

The MBSS team recognizes that, although the 1995-1997 MBSS was designed to focus on the overall condition of Maryland's streams, it includes information that can help characterize components of the state's biodiversity. Specifically, the number of total and rare fish species is known for each site and can be extended to larger regions. Significantly, the Survey provides an independent validation of the rarity of species and their appropriateness for listing as endangered, threatened, or of special concern by DNR.

At the same time, the 1995-1997 MBSS has limitations related to its random sampling design. It did not capture all of the rare species known from the state; nor did it recognize rare aquatic communities. Several options exist for enhancing the biodiversity information in the second round of the Survey. Time-series information can be used to determine trends in population abundances that may indicate species declines. Sampling may need to be focused in selected regions to provide accurate estimates of rare species. Such sampling may also identify sources of eggs for use in reintroducing declining species into areas from which they have been extirpated. The cluster analysis done on fish assemblages in minimally impaired streams could be expanded to create a classification of aquatic community types to be investigated for potential endangerment. Threats to rare species could be identified, especially the spread of exotics into streams previously supporting only native species. Lastly, MBSS information on the ecological condition of entire watersheds can be used to help designate biodiversity protection areas or to identify potential threats to known biodiversity hotspots.